

Discover the Universe

BUSHNELL®

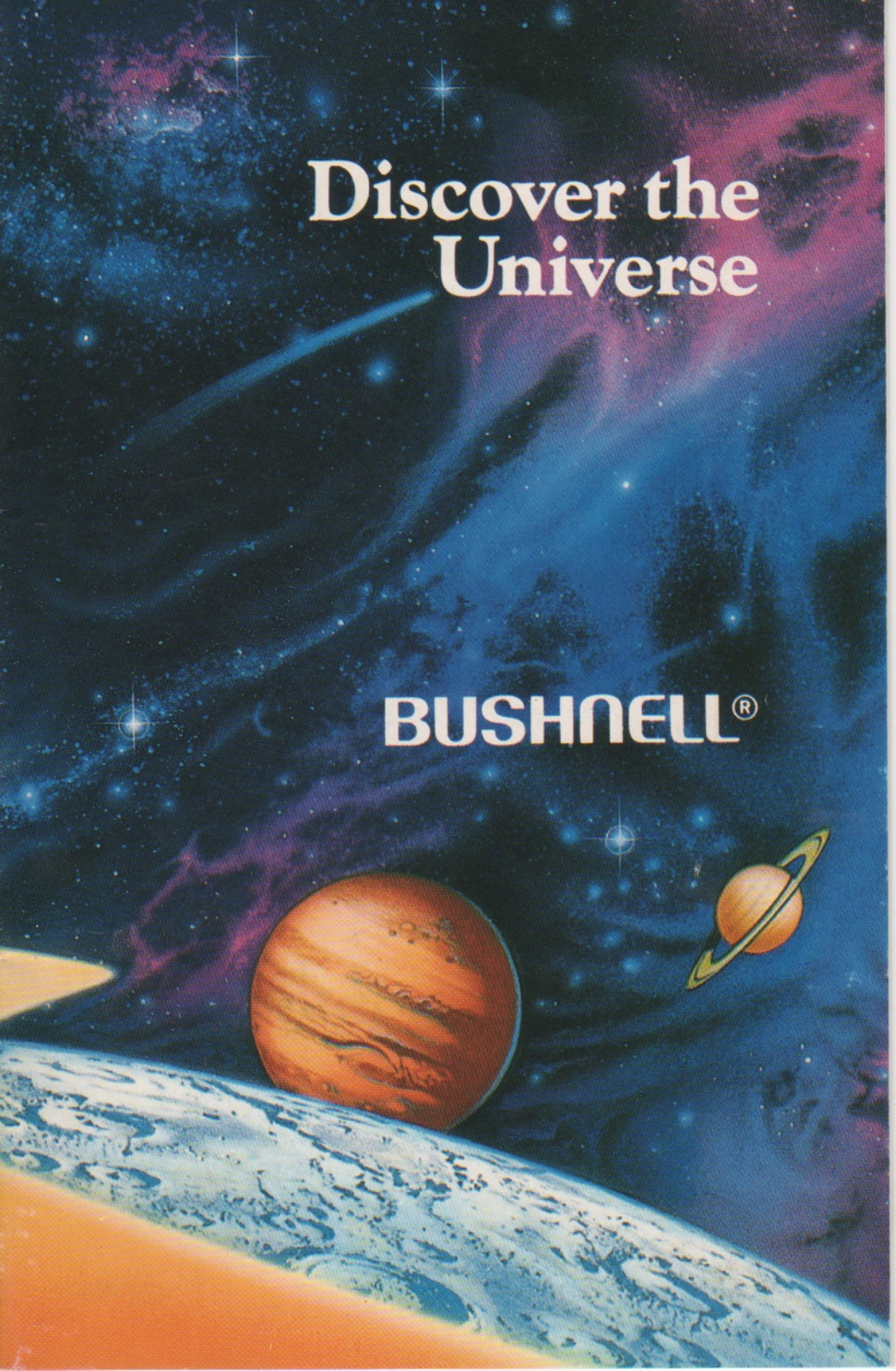


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Galileo...Father of the Modern Telescope.

1



More than 400 years ago, Galileo founded modern physics. His discoveries, methods, and creativity provided Isaac Newton with the laws and principles needed for him to discover the laws of gravity. Equally important, he invented and used his telescope to prove our planet is only one part of a sun centered solar system. Galileo records that he designed and built no less

than 100 telescopes. But only a handful were good enough to use; efficient enough to bring distant objects 30 times closer. In 1610 A.D. his finest telescope, the one he used regularly to explore the heavens, provided him with a sharp image only at the center of his lens. Despite fuzziness and "rainbows" surrounding the center image (today called "aberrations") he was able to explore and understand the celestial wonders his telescope revealed each night.

As a result of his explorations, Galileo created an entirely new science...Astronomy. Since then, Astronomers have continually strived to perfect the telescope. Indeed, designing and manufacturing telescopes has become a science in and of itself.

Your Bushnell telescope is a product of that science. It has been designed and engineered to provide you with a superior optical system. With it you can easily begin to explore the galaxies visible from the Earth.

Have the heavens above you changed since Galileo first tilted his telescope skyward? Your Bushnell telescope will help you answer that question.

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1 Finder Scope

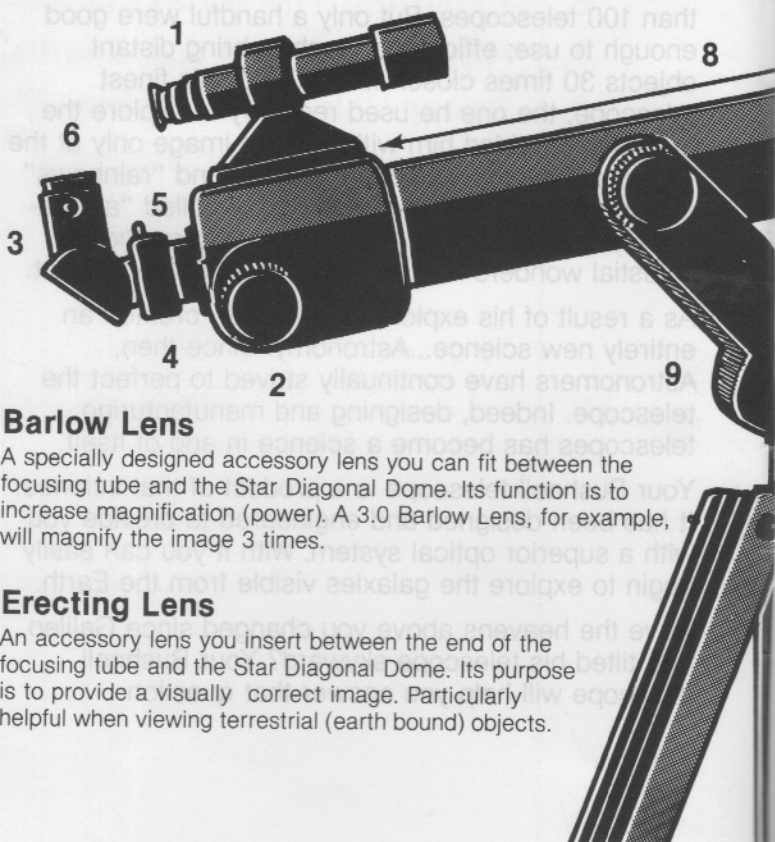
Makes it easy to scan and locate celestial bodies. Once you've located what you're looking for, use the main telescope for close observation.

2 Focusing

This knob controls the rack and pinion focusing system. Permits smooth movement of the eyepiece in or out for precise, sharp images. Never force the control.

3 Star Diagonal Dome

It rotates to permit viewing from virtually any comfortable position or angle.

**4 Barlow Lens**

A specially designed accessory lens you can fit between the focusing tube and the Star Diagonal Dome. Its function is to increase magnification (power). A 3.0 Barlow Lens, for example, will magnify the image 3 times.

5 Erecting Lens

An accessory lens you insert between the end of the focusing tube and the Star Diagonal Dome. Its purpose is to provide a visually correct image. Particularly helpful when viewing terrestrial (earth bound) objects.

Telescope.

6 Interchangeable Eyepieces

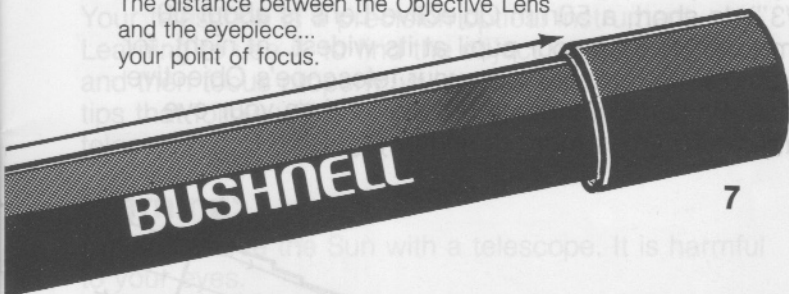
Each eyepiece inserts into the Star Diagonal Dome. Each eyepiece has its own lens; is measured in terms of magnification. The size of the lens is expressed in millimeters (mm). For a bigger image, use an eyepiece with a larger number (ie: 20mm). For close-ups, use an eyepiece with a smaller number (ie: 5mm).

7 Objective Lens

Ultra-sharp, coated for superior light gathering properties. Aberration free. Your Bushnell telescope features a technologically superior achromatic objective lens that provides bright, clear, and sharp images.

8 Focal Length

The distance between the Objective Lens and the eyepiece... your point of focus.

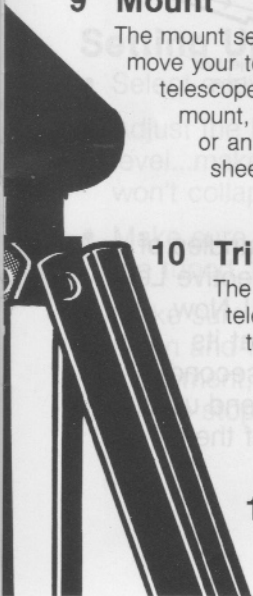


9 Mount

The mount secures the telescope to the tripod. It allows you to move your telescope horizontally and vertically. Your Bushnell telescope will come equipped with a standard Alt Azimuth mount, an Alt Azimuth mount with vertical micro-adjustor, or an Equatorial mount. Refer to the special information sheet that comes with your telescope.

10 Tripod

The tripod serves as a steady platform for your telescope. It allows you hands-free use of your telescope...because of its powerful magnification, even the slightest jiggle of the telescope is enough to move it from your target. Your tripod has three adjustable legs so you can use your telescope even when the ground is uneven.

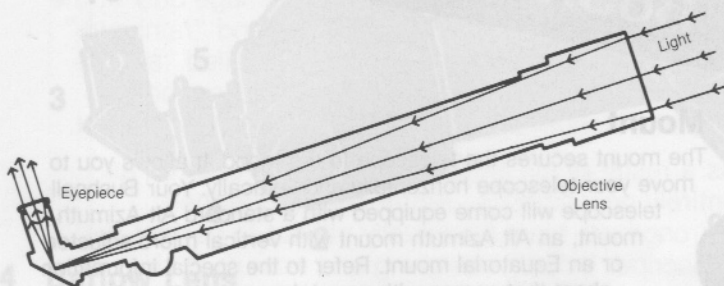


3

How Your Telescope Works.

Your telescope is a sophisticated light gathering system. It gathers light with the objective lens, allows the light to travel the telescope's focal length, then bends the light toward your eyepiece by using a mirror or a prism. Your job is easy...all you have to do is focus your eyepiece so the image you see is clear, and sharp. Sounds simple, but it's really quite remarkable. Consider this...

The objective lens is like your eye's pupil. But, the objective lens is considerably larger (ie: 50mm, about 2") than your night-time pupil (ie: 7mm, just about 1/3"). In short, a 50mm Objective Lens is about 50 times larger than your pupil at its widest...at night, for example. Put another way, your telescope's Objective Lens will gather 50 times more light than your eye (almost 70 times more during daylight)!



Light is composed of "photons"...invisible bundles of energy that stream into the telescope's Objective Lens at approximately 186,000 miles per second! Now, since an objective lens is about 1/2" thick at its middle, the lens has only 1/2 billionth of a second to change the path of the photons so they end up at the proper focal point. Changing the path of the photons is called "refraction."

Each eyepiece has a different magnifying power. The lower its number (ie: 4mm) the greater the magnification. For example, a 4mm eyepiece magnifies images 5 times more than a 20mm eyepiece. But, there is a price to pay for greater magnification...

The greater the power, the smaller the field of view. And, the greater the power the more vibrations and distortion (usually caused by a heated or windy atmosphere) are seen. Even a slight touch of your hand appears to be big bounce when seen through a high power eyepiece.

Using Your Telescope.

4

Your telescope is a precision optical instrument. Learning to use it, to find the object you're looking for, and then focus properly, will take a bit of practice. The tips that follow will help you become familiar with the telescope and its use.

Warning:

Never observe the Sun with a telescope. It is harmful to your eyes.

Setting Up

- Select a level spot to set up your telescope.
- Adjust the legs so the top of the tripod is level...make sure leg adjustments are tight so they won't collapse.
- Make sure your telescope is securely mounted to the tripod. Don't over-tighten the mounts.
- Make sure the telescope moves smoothly up-and-down and from side-to-side. When you stop the movement, the telescope should remain where you've stopped it.

Solar System
4 Mars
3 Earth
2 Venus
1 Mercury

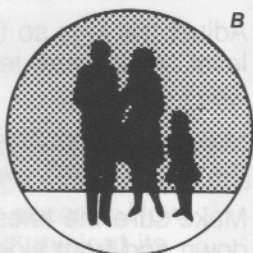
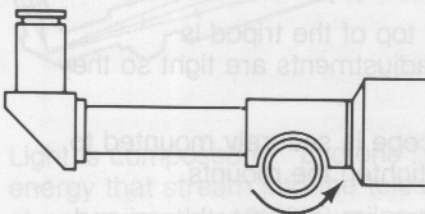
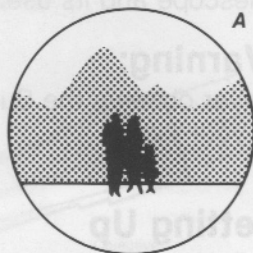
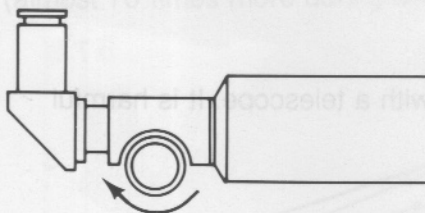
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Observing

- Atmospheric conditions, wind, heat, etc. can cause minor image distortion. To learn the difference, start observing when the weather is calm, temperatures are moderate, and the night sky is bright. Then when distortion occurs, you'll easily recognize it.
- Use the relatively low power Finder Scope to scan the sky. Because its field of view is wider, you'll be able to locate objects more quickly and easily. Use the crosshairs to center the object you want to observe closely.
- Once you've located an object, start observing with the lowest number eyepiece. Then, as your observations progress, switch to the next highest number for a closer look. That way you'll always know where you are...and what you're looking at.
- When focusing, turn the focus control knob slowly and carefully. The process of focusing is called "Racking." You'll "Rack In" for distant objects... "Rack Out" for objects nearby.

A *Racking In*
For viewing
distant
objects.

B *Racking Out*
For viewing
nearby
objects.

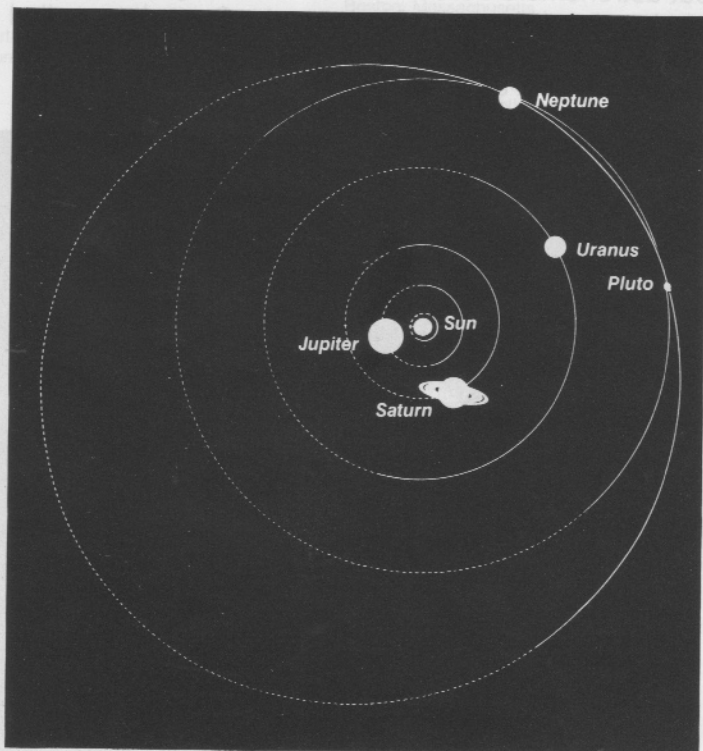


- If you've never used a telescope before, start by looking at something about 100 feet away, something you're familiar with. You won't be able to focus on things within 20 feet. This will help you understand that things often look quite different when viewed with a high power lens.

- When using your telescope, keep your hand movements slow and steady. Using two hands while scanning will help keep the telescope steady.
- **Caution!** Never drop your telescope or try to take it apart. Severe damage to the internal optical system will result. You can clean the objective lens, and your eyepiece with a very soft, lint-free cloth...or...use a lens cleaning kit available at camera stores.

Exploring The Galaxy ...The First Step.

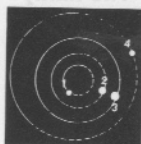
This diagram of the Sun's family, or Solar System, shows that the Earth is one of nine planets orbiting our star, the Sun. All of the planets, except



5

Solar System

The Earth is one of nine planets in our solar system.



- 4 Mars
- 3 Earth
- 2 Venus
- 1 Mercury

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Venus and Mercury, have at least one moon. Our Moon is the biggest in the solar system compared to the size of the planet it orbits—in fact, the Earth and Moon are almost a double planetary system! We will learn a lot more about the Moon later but let's move deeper into space.

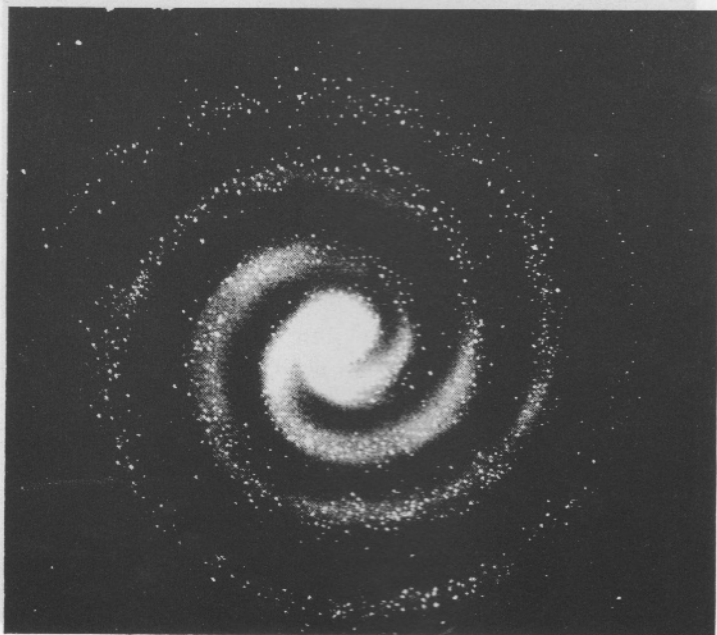
The Sun is a single star and does not share its part of space with any other star. This is rare because many of the other stars near the Sun are double or triple stars which orbit each other.

After many hundreds of years of study, astronomers around the world agree that the Sun is an ordinary star in what might look like a gigantic saucer-shaped star system. This gigantic star system is called a "galaxy." The galaxy contains at least 100 billion stars, plus a lot of gas (mostly hydrogen), dust (mostly iron and carbon), and lots of energy. In fact, the free gas and dust might weigh as much as the 100 billion stars!

No one has ever seen our galaxy from the outside, but astronomers believe that modern diagrams showing its shape and size are fairly accurate. Our galaxy, called the Milky Way Galaxy or The Home Galaxy, is almost too big to think about at one time.

The Milky Way

Our home galaxy.



The following comparison chart will help you understand how big our galaxy is. To make the comparison work, we have to use the speed of light as the measuring stick. Remember the photons zip along at about 186,000 miles each second they travel. (You might want to use a calculator here to follow along.) Let's look at some distances between objects in space and the time it takes photons to travel between them.

Separation of Objects

Photon Travel Time at 186,000 mi/sec

Earth to Communication Satellites 22,300 miles (the kind that relay television and telephone signals).	about $\frac{1}{10}$ of a second or an eye blink.
Earth to the Moon; 250,000 miles.	about $1\frac{1}{2}$ seconds or the time it takes to cough once.
Earth to Mars at its closest point (about 40,000,000 miles).	about 215 seconds or 4 minutes, the time it takes to boil an egg in Denver, Colorado.
Earth to the Sun about 93,000,000 miles	500 seconds or 8 $\frac{1}{2}$ minutes—about the time between T.V. commercials on Saturday mornings.
Earth to Pluto about 3.6 billion miles	19,355 seconds or 322 minutes, or about 5.4 hours. This is about the time needed to drive from Philadelphia, Pennsylvania, to Boston, Massachusetts.
Earth to the Oort Cloud* of Comets surrounding the Sun—about 1 trillion miles	5,376,634 seconds or 89,605 minutes or 1,493 hours or 62.2 days or about 9 weeks. That's about equal to your summer vacation from school!
Earth to the brightest and nearest star in the night sky visible to most Americans—Sirius—about 54 trillion miles.	290 million seconds, or about 9 years. That's about how long it took you to get to third grade from the time you were born. You see we now have to think about star distances in terms of time—and we have only reached the nearest visible star for most Americans, not counting the Sun.
Earth to brightest star in the summer sky seen by most Americans—Vega—about 156 trillion miles.	838 million seconds or 26 years. That is about how long humans have been exploring space with satellites.
Earth to Mizar, a bright double star in the handle of the Big Dipper—444 trillion miles.	2.4 billion seconds or about 75 years. This is the average age that most Americans live.
Earth to the brightest space gas cloud visible with the unaided eye to most Americans—The Orion Nebula—9,000 trillion miles.	48 billion seconds or 1,500 years. The photons you will see the Orion Nebula with next fall and winter started their trip when Europe entered what is known as the Dark Ages; c. 490 A.D.
Earth to the Andromeda Galaxy, the brightest galaxy visible in America (about 14 thousand, thousand trillion miles).	76 trillion seconds or 2.4 million years. The photons you see when you look at the Andromeda Galaxy left there before there were humans like us on this planet. I wonder who or what will see the Andromeda photons leaving that galaxy now when they finally reach Earth in about 2 $\frac{1}{2}$ million years!

Because space is so big we have had to introduce two new ways to describe distances. The first new method or way concerns itself with distances within the solar system. Instead of miles, we use Astronomical Units, almost always shown by the letters "A.U." This is done for convenience. Here is a table showing the distances to solar system objects from Earth. One A.U. equals about 93,000,000 miles.

Table of Distances

Planet Name	Planet Symbol	Distance in Millions of Miles (1,000,000)	Number Shorthand*	A.U.
Mercury	☿	57	57×10^6	0.613
Venus	♀	26	26×10^6	0.268
Earth	⊕	0	0	0
Mars	♂	49	49×10^6	0.524
Sun	☉	93	93×10^6	1
Jupiter	♃	390	390×10^6	4.203
Saturn	♄	794	794×10^6	8.539
Uranus	♅	1,690	1.69×10^9	18.182
Neptune	♆	2,700	2.7×10^9	29.058
Pluto	♇	3,700	3.57×10^9	38,439

You can see that space is so big that most of what we see are old photons from very distant places. Our brains take in all this information and try to create a theory to explain what we see. Sometimes the theories created are correct but often they are not correct and have to be changed when we provide more information.

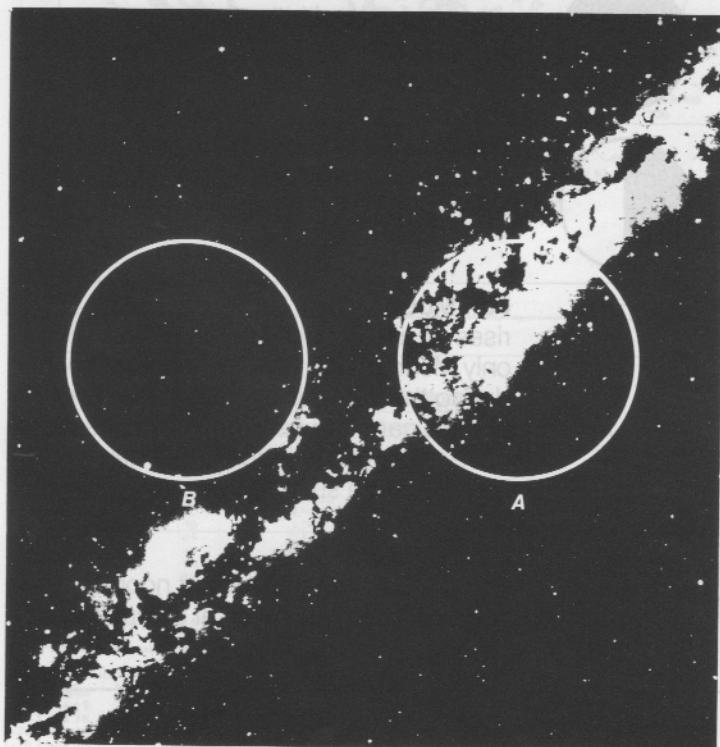
How far away are most of the objects you will be looking at in space with your telescope? The part of the galaxy we live in is very dusty and has a lot of gas clouds, not to mention many stars. This means that if you look around in the band of the Milky Way Galaxy, you can see stars only about 3,000 light years away. But if you look away from the band of the Galaxy, you will be able to see right out of our galaxy! On the

average, let's say you can see a ball-shaped piece of space about 6,000 light years across. The amount of space in that sphere is enormous—gigantic—mind boggling!

The volume is about 113,097,000,000 cubic light years. If you want to know the formula for this calculation it is:

$$\text{Volume} = \frac{4}{3} \pi r^3$$

The r^3 is the radius (3,000 light-years in this case) of the sphere. The 3 above the r means you multiply the value for r times itself three times. In that vast space are billions of stars, star clusters, gas clouds of enormous size, our planets and Moon, and many other exciting objects to discover.



π

is the symbol for Pi, which equals 3.14.

- A** 3000 Light Years Away
B 6000 Light Years Away

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6 Exploring The Galaxy ...6 Places to Discover.

1. The Moon

Our Moon is so close and so big that you can see its largest craters without a telescope. Those big splotches you see on the Moon, day or night, are really gigantic craters, the largest of which contain hundreds of thousands of square miles—bigger than most states in the United States.



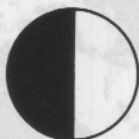
The Moon
381,575 km
from Earth
and is .25 of
the size of
the Earth.

The Moon's Phases



New Moon

rises and sets with the Sun.



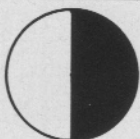
First Quarter Moon

rises at Noon and sets at midnight.
This Moon is due south at sunset.



Full Moon

rises at sunset and sets at dawn. It is the only Moon phase which cannot be seen during the day—all the rest of the Moon phases can! The new moon is a special case—you can see it during the day when it eclipses the sun.



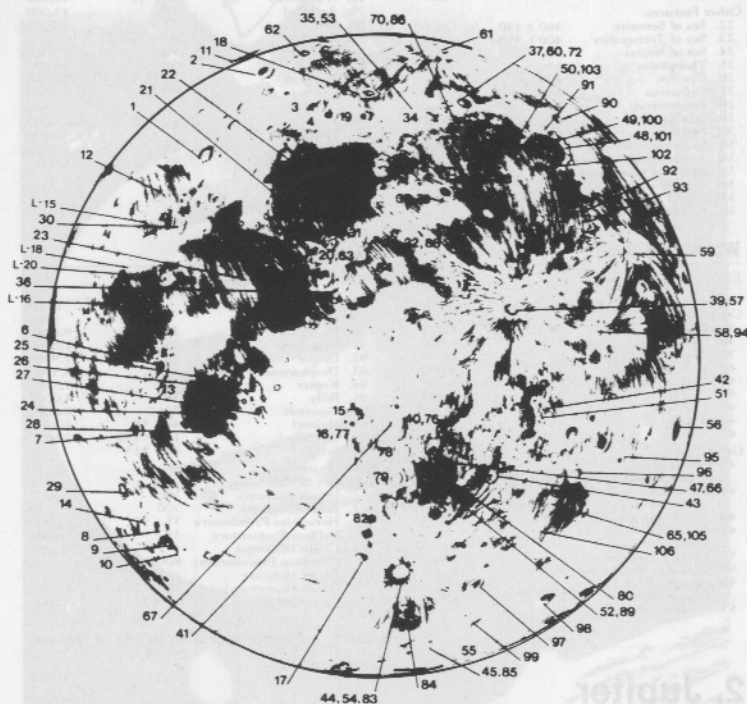
Last Quarter Moon

rises at midnight and sets at noon.
You can see it due south at dawn.

To see the thousands of smaller craters, you do need optical help. There are at least 20,000 craters on the Moon big enough to see with your telescope.

The Moon map below and the corresponding guide on the next page will be of great help in finding and naming the more important features on the Moon.

Moon Map



Jupiter
778,300,000
km from the
Sun. Its size is
11.2x greater
than the Earth

Guide to the Moon

Crescent Moon

Up to Four Day Moon

Craters:	Diam. (miles)	Depth* (feet)
1. Cleomedes	81 x 92	14,300
2. Endymion	77	16,100
3. Atlas	54	10,000
4. Hercules	20	4,900
5. Tarantius	36	3,000
6. Gutenberg	45	7,500
7. Sanbech	40	13,100
8. Metius	50 x 55	18,600
9. Fabri	48	14,400
10. Janssen	122 x 153	9,300

Other Features:

11. Sea of Humboldt	145 x 170	10,000
12. Sea of Crises	270 x 350	14,400
13. Pyrenes Mountains	45 x 165	+6,100 - 10,800
14. Rheita Valley	15 x 230	8,400

Lunar Probes:

L-15 Luna 15
L-18 Luna 18
L-20 Luna 20
L-16 Luna 16

Full Moon

Eleven to Seventeen Day

Craters:	Diam. (miles)	Depth (feet)
54. Tycho	56	13,800
55. Bailly	200	13,800
56. Grimaldi	140 x 145	10,500
57. Copernicus	60	12,600
58. Kepler	20	7,500
59. Aristarchus	25	11,900
60. Plato	64 x 67	8,000
61. Anaxagoras	33	8,900
62. Thales	22	5,900
63. Manilius	25	9,300

Other Features:

64. Sea of Vapors (Mare Vaporum)	115 x 160	
65. Sea of Moisture (Mare Humorum)	250 x 275	4,900
66. Sea of Clouds (Mare Nubium)	350 x 400	
67. Tycho Ray	800	
68. Sea of Rains (Mare Imbrium)	670 x 750	10,000
69. Teneriffe Mountains	35 x 65	+6,200
70. Pico	10 x 18	+9,600
71. Piton	11 x 17	+8,200

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First Quarter

Five Day to Seven Day

Craters:	Diam. (miles)	Depth (feet)
15. Hipparchus	83 × 89	7,500
16. Albategnius	81	14,400
17. Stofler	68 × 85	7,500
18. Aristotle	55	12,000
19. Eudoxus	40 × 43	14,300
20. Manilius	25	9,300
21. Bessel	10	5,200
Other Features:		
22. Sea of Serenity	360 × 420	
23. Sea of Tranquility	400 × 550	
24. Sea of Nectar	220 × 265	
25. Theophilus	65	22,300
26. Cyrtillus	20 × 30	8,200
27. Catharina	64	9,200
28. Fracastorius	73	5,800
29. Stevinus	48	15,400
30. Proclus	18	11,900
31. Haemus Mountains		+9,000
32. Apennine Mountains		+15,000
33. Caucasus Mountains		+17,000
34. Alps Mountains		+12,000
35. Alpine Valley	110 × -13	
36. Ariadaeus Rill	145	

Last Quarter

Three to Twenty-four Day Moon

Craters:	Diam. (miles)	Depth (feet)
72. Plato	64 × 67	8,000
73. Aristillus	36	10,500
74. Autolycus	25	11,100
75. Archimedes	51	6,800
76. Ptolemy		
77. Albategnius	81	14,400
78. Alphonsus	64 × 73	10,500
79. Arzachel	59	13,000
80. Birt	11	7,700
81. Birt A	4.2	
82. Werner	43	15,000
83. Tycho	56	13,800
84. Maginus	100 × 115	16,400
85. Clavius	19	9,500
Other Features:		
86. Pico	10 × 18	+9,600
87. Piton	11 × 17	+8,200
88. Apennines	450	+15,000
89. Straight Wall	75	1,200

Waxing Gibbous

Eight Day to Ten Day

Craters:	Diam. (miles)	Depth (feet)
37. Plato	64 × 67	8,000
38. Archimedes	51	6,800
39. Copernicus	60	12,600
40. Ptolemy	93	9,800
41. Ptolemy A	6	3,900
42. Euclid	8	4,400
43. Bulliadus	38	11,300
44. Tycho	56	13,800
45. Clavius	132 × 152	16,100
Other Features:		
46. Sea of Rains (Mare Imbrium)	670 × 750	10,000
47. Sea of Clouds (Mare Nubium)	350 × 400	
48. Bay of Rainbows	300	13,000
49. Bay of Rainbows (Sinus Iridium)	160	12,700
50. LaPlace Promontory	35	9,900
51. Rhiphaeus Mountains	30 × 110	4,100
52. Straight Wall (Rupes Recta)	75	1,200
53. Alpine Valley	110	

Waning Crescent

Twenty-five to Twenty-seven Day

Craters:	Diam. (miles)	Depth (feet)
90. Harpalus	26	9,800
91. Bianchini	25	10,000
92. Delisle	17	7,900
93. Diophantus	12	8,500
94. Keppler	20	7,500
95. Billy	30	4,000
96. Gassendi	70	6,600
97. Hainzel	44 × 58	10,500
98. Schickard	135 × 150	9,500
99. Schiller	48 × 113	
Other Features:		
100. Bay of Rainbows (Sinus Iridium)	160	
101. Jura Mountains	300	+12,700
102. Heraclides Promontory	35 × 50	+5,900
103. LaPlace Promontory	35	9,900
104. Ocean of Storms (Oceanus Procellarum)	800,000 mi ²	
105. Sea of Moisture (Mare Humorum)	250 × 275	4,900
106. Cape Kelvin	13 × 30	6,200

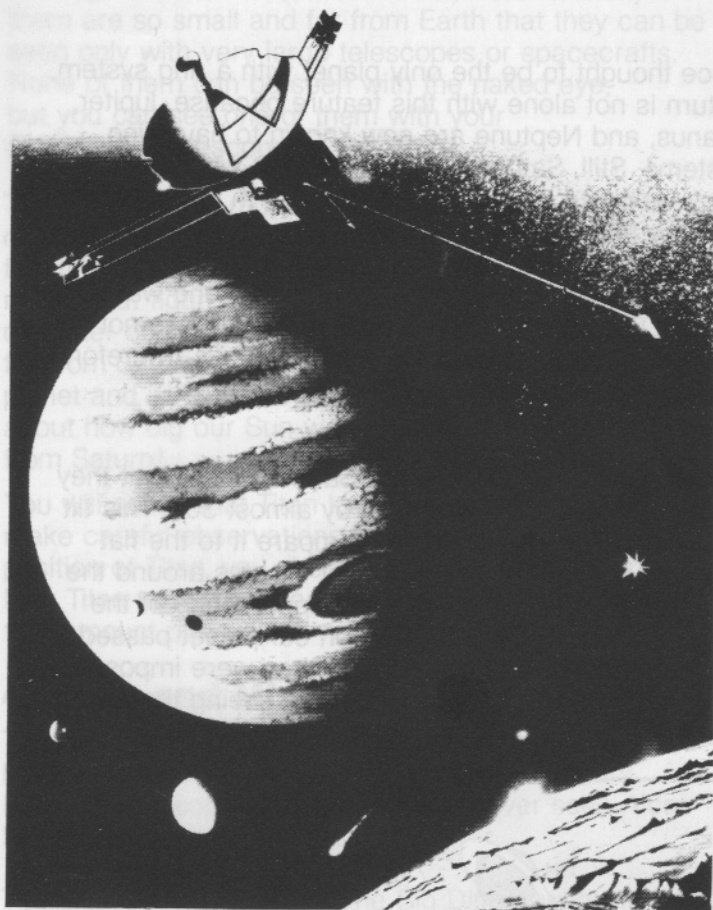
* + preceding a number indicates height of feature.

2. Jupiter

Jupiter is the largest planet in our solar system. We know a lot more about Jupiter than we ever did because of the robot spacecrafts sent there by NASA.

The bands of Jupiter consist of light "zones" that range in color from pure white to pale yellow, and dark "belts" of various shades of reddish brown. The zones and belts near the equator are permanent bands that vary slowly in width and color. They occasionally split into sub-bands. The most prominent marking on Jupiter is the Great Red Spot, which has been observed for more than 300 years since its discovery by Giovanni Domenico Cassini.

When observing Jupiter through your scope, pay attention to the star-like points of light near the planet. These are Jupiter's brightest moons. If you see more than four points of light, the extras must be stars quite



far behind Jupiter because all of Jupiter's other moons are too dim to be seen with anything but a very large telescope. Watch the moons carefully and draw them to show their position next to the planet. After a few hours, or the next night, observe Jupiter's moons again and you will see that they have changed their position from your previous observation.

Observing Jupiter and its moons is just like watching a tiny solar system at work in some distant part of the galaxy. As you read other books about Jupiter, you will learn about other amazing features of the planet, many of which you can hunt for with your telescope. Use the high-power eyepiece only when the planet is high in the sky and the air is steady.



Jupiter

778,300,000
km from the
Sun. Its size is
11.2x greater
than the Earth.

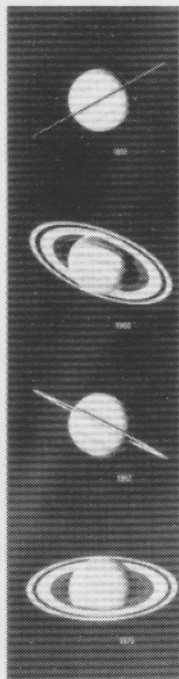


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3. Saturn

Saturn

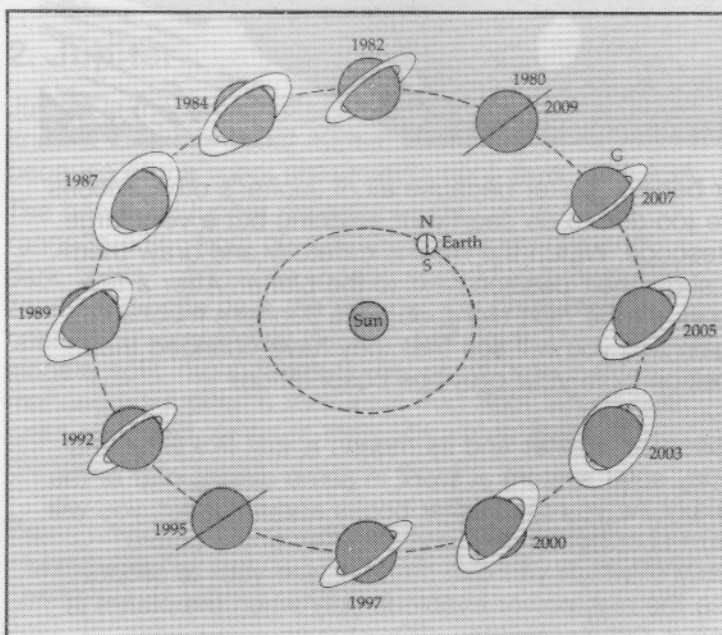
1,427,000 km from the Sun. Its size is 9.4x greater than the Earth. Saturn has a surface temperature of -300°F .



The tilt of Saturn's rings is constant—our position in the sky changes and so our view of them changes.

Once thought to be the only planet with a ring system, Saturn is not alone with this feature because Jupiter, Uranus, and Neptune are now known to have ring systems. Still, Saturn is the only planet which has rings visible to telescopes here on Earth and, once you see them, you will agree that they are a fabulous sight. Like Jupiter, Saturn is a planet made mostly of gases like hydrogen, ammonia methane, and water clouds. For some reason though, its surface is not banded, striped, and mixed-up like Jupiter's. Therefore, the main visual attraction of the planet is its ring system.

When you look at the rings of Saturn, notice that they appear to be tilted towards us by almost 30° . This tilt of the rings is constant if we compare it to the flat plane of space that Saturn's orbit creates around the Sun. But for most observers the appearance of the rings change. In 1979-1980 when our planet passed through the plane of these rings, they were impossible to see from Earth because we were seeing them from the side. This will happen again in 1995-1996.



Although Saturn has at least twenty moons, many of them are so small and far from Earth that they can be seen only with very large telescopes or spacecrafts. None of them can be seen with the naked eye, but you can see one of them with your BUSHNELL telescope.

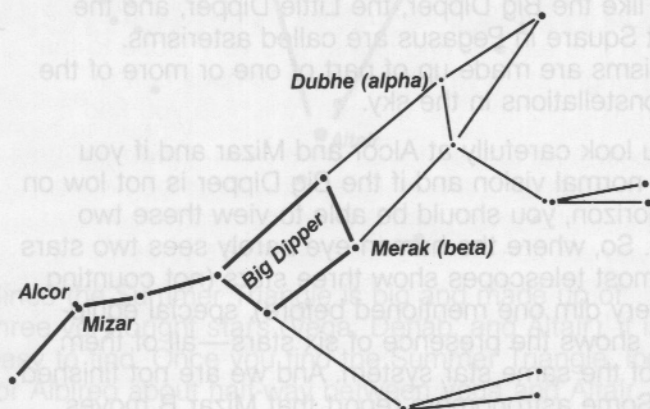
The name of this moon is Titan, the largest moon in our solar system. Titan's orbit carries it out as far as five times the diameter of the rings, or about 847,000 miles. That figure also happens to be the approximate diameter of the Sun. In other words, when Titan is as far from Saturn as it can get, and you see both the planet and its moon in your telescope, you are seeing about how big our Sun would look when viewed from Saturn!

You will notice that Titan looks like a tiny star. If you make careful observations and record the time and position of Titan, you should be able to find out how long Titan takes to go around Saturn one time. We call that amount of time *one rotational period*.

4. Alcor and Mizar

These two stars are also called the Horse (Mizar) and Rider (Alcor) and they are known as double stars. Most of the people alive today have never seen Alcor Mizar through a telescope.

The diagram below shows the Big Dipper with the star names. Notice that Alcor and Mizar are the middle stars in the handle of the Dipper.



Ursa Major
(The Big Bear)
Also known as the Big Dipper. Alcor and Mizar appears on the left side of this constellation.

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These are the
Astrological
symbols for
the seasons.



SPRING



SUMMER



AUTUMN



WINTER

BUSHNELL®

Most of the Big Dipper stars are about the same distance apart because they are part of a cluster of stars that formed together. The brightest star in our night sky, Sirius, best seen in the winter sky is also part of this cluster.

Put your low power eyepiece in place and focus on Alcor and Mizar. You are now seeing something that billions of people will never see or know about. Mizar, as you can see when you look at it carefully through your telescope after it steadies down, is also a *double star*. It is the first double star to be discovered with a telescope. An Italian astronomer, G.B. Riccioli found it by accident in 1650—almost 340 years ago.

If you look really, carefully, you will see a very dim star in the same field of view as Alcor and the two Mizars. The brighter, Mizar is called Mizar A and the dimmer star is called Mizar B. The B star is about the same brightness as Alcor, and it is very close to Mizar A.

What you see in your telescope is special but don't think you have discovered all there is to know about these stars. There are thousands of men and women around the world who study the stars with all sorts of large telescopes which are connected to computers, fantastic cameras, and all sorts of very specialized equipment. These are astronomers who have discovered that Alcor and Mizar A and B is each a *double star*. So, each star you see is really two stars.

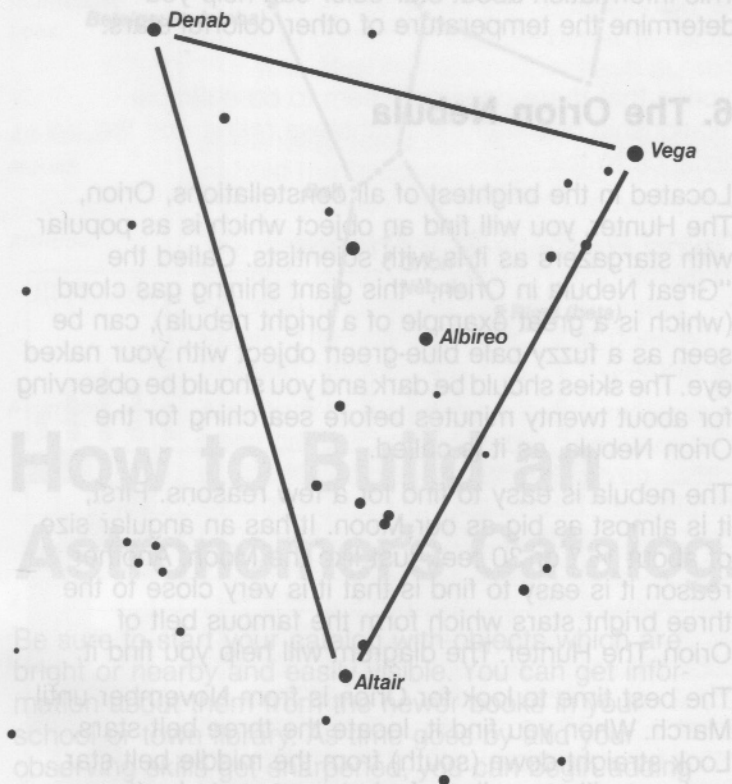
When you look at these stars, you have left our solar system light years behind. Alcor and Mizar are part of a pattern of stars called the Big Dipper. Patterns of stars like the Big Dipper, the Little Dipper, and the Great Square in Pegasus are called asterisms. Asterisms are made up of part of one or more of the 88 constellations in the sky.

If you look carefully at Alcor and Mizar and if you have normal vision and if the Big Dipper is not low on the horizon, you should be able to view these two stars. So, where the human eye barely sees two stars and most telescopes show three stars (not counting the very dim one mentioned before), special equipment shows the presence of six stars—all of them part of the same star system. And we are not finished yet! Some astronomers report that Mizar B moves

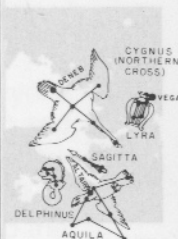
through space as though some unseen star is pulling on it. Therefore, there are really 7 stars where the eye sees only 2.

5. Albireo

This star is probably the most beautiful and colorful double star visible from Earth. It is also fairly easy to find. Recall that we used the word asterism when describing the Big Dipper. We also mentioned another star pattern called the Summer Triangle. It looks like the diagram below. The Summer Triangle is your key to finding Albireo.



Since the Summer Triangle is big and made up of three very bright stars (Vega, Denab, and Altair), it is easy to find. Once you find the Summer Triangle, look for Albireo about half-way between Vega and Altair. Albireo is the brightest star in this half-way area.



To find the Nebula align the telescope with the constellation and find the Orion Nebula.

Your eyes will show Albireo as a single star. Compare it to Alcor and you will see Albireo is more than twice as bright.

Not only will you see two stars instead of one, but note the colors—the brighter star should look sort of gold in color while the dimmer one is a pale blue.

It might surprise you to know that the smaller appearing blue star has a higher temperature than the larger appearing orange star, but it is true. Our Star, the Sun, is a yellow star, which means it is closer in temperature to the gold star than to the blue star. You can see that blue stars are hot and red stars are cooler, and yellow star are in-between.

This information about star color can help you determine the temperature of other colorful stars.

6. The Orion Nebula

Located in the brightest of all constellations, Orion, The Hunter, you will find an object which is as popular with stargazers as it is with scientists. Called the "Great Nebula in Orion," this giant shining gas cloud (which is a great example of a bright nebula), can be seen as a fuzzy pale blue-green object with your naked eye. The skies should be dark and you should be observing for about twenty minutes before searching for the Orion Nebula, as it is called.

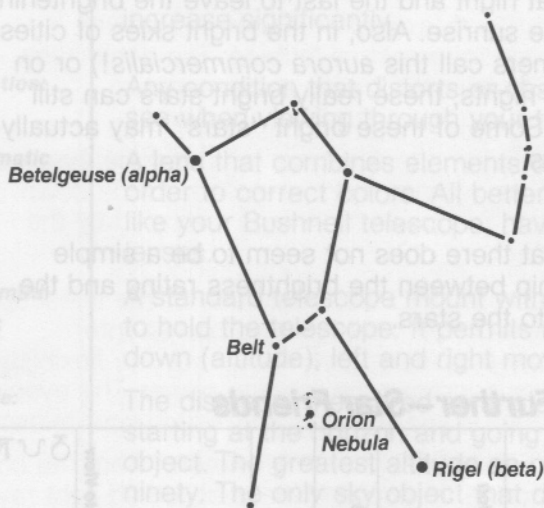
The nebula is easy to find for a few reasons. First, it is almost as big as our Moon. It has an angular size of about $\frac{1}{2}^\circ$ or 30 feet, just like the Moon. Another reason it is easy to find is that it is very close to the three bright stars which form the famous belt of Orion, The Hunter. The diagram will help you find it.

The best time to look for Orion is from November until March. When you find it, locate the three belt stars. Look straight down (south) from the middle belt star and you will see a line of what appears to be three stars. These lower three "stars" are called the *Sword* of Orion. They are anywhere from 6 to 15 times dimmer than the "Belt Stars." The middle "star" in the sword is actually the nebula. Use your 20mm eyepiece to carefully inspect the gas cloud.



To find the Nebula
align the telescope with Betelgeuse and the belt of Orion.

Astronomers understand that our eyes contain two different kinds of special cells which work closely with the brain to produce the image we "see." There are about 6 or 7 million cells called "cones" packed tightly around the central focus of the eye. These cones work terrifically in bright light and they provide us with color vision and our sharpest focus. However, they do not work that well in dim light, like when you are looking at the Orion Nebula.



How to Build an Astronomer's Catalog.

7

Be sure to start your catalog with objects which are bright or nearby and easily visible. You can get information about them from the newer books in your school or town library. As time goes by and your observing skills get sharpened, you can begin adding dimmer and more difficult-to-find objects. Soon, you'll be able to "see" objects and features that are practically invisible to the unaided eye. If you do invite friends or family to look into your scope, be sure to pick bright and easy to see objects because their observing skills are not as good as yours.

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8

Recognizing the Brighter Stars.

After using your telescope for a while, you will notice that there are a few stars that are very much brighter than others. They are the first to appear as the sky darkens at night and the last to leave the brightening sky before sunrise. Also, in the bright skies of cities (astronomers call this *aurora commercialis*!) or on full-moon nights, these really bright stars can still be seen. Some of these bright "stars" may actually be planets.

Notice that there does not seem to be a simple relationship between the brightness rating and the distance to the stars.

Going Further—Star Friends

-  Season Visible
 Best Possible Time to View

Star Name	Constellation	Brightness Rating	Distance L.Y.	Color	Best Time to View	♈ ♉ ♊ ♋			
						Spring	Summer	Winter	Fall
Sirius	Canis Major	1	9	White					
Arcturus	Bootes	2	36	Yellow-Orange					
Vega	Lyra	3	26	White					
Capella	Auriga	4	42	Yellow-White					
Rigel	Orion	5	913	Blue-White					
Procyon	Canis Minor	6	11	Yellow-White					
Betelgeuse	Orion	7	310	Reddish-Orange					
Altair	Aquila	8	17	White					
Aldebaran	Taurus	9	68	Yellow-Orange					
Antares	Scorpius	10	326	Reddish-Orange					
Spica	Virgo	11	258	Bluish-White					
Pollux	Gemini	12	36	Yellow-Orange					
Fomalhaut	Picis	13	22	White					
Austrinus Deneb	Cygnus	14	1,826	White					
Regulus	Leo	15	85	White					

9 An Astronomical Glossary

Every science and hobby has its own vocabulary. If you understand an astronomer's basic vocabulary, your understanding and enjoyment of your telescope, how it works, and what you'll see with it, will increase significantly.

Aberration:

Any condition that distorts or obscures the image you see when viewing through your telescope.

Achromatic

Lens:

A lens that combines elements of differing density in order to correct colors. All better refractor telescopes, like your Bushnell telescope, have achromatic objective lenses.

Alt-Azimuth

Mount:

A standard telescope mount with a U-shaped yoke to hold the telescope. It permits movement up and down (altitude); left and right movement (azimuth).

Altitude:

The distance, measured as angle, of any sky object starting at the horizon and going straight up to the object. The greatest altitude an object can have is ninety. The only sky object that does not change its position noticeably is Polaris, the North Star.

Asterism:

A pattern of stars which is so recognizable that it has been given a special name. The stars might be a part of one constellation (like the Seven Sisters, the Big Dipper, or the Little Dipper) or made up of two or more constellations (like the Summer Triangle, Great Square in Pegasus).

A.U. or

Astronomical

Unit:

This is a unit of measure used within the solar system for distance between planets. An A.U. is defined as 499.004782 light seconds. Since the speed of light equals 186,287.5 miles/seconds, an A.U. must equal the product of these two numbers or 92,958,349 miles. You can see that this is also the distance between the Earth and the Sun.

Azimuth:

The angle measured along the horizon of any sky object. The angle is measured in degrees (360° in a circle) and it starts at the north point and moves around clockwise. So: north has an azimuth of 0° ; east = 90° ; south = 180° ; west = 270° .

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Barlow**Lens:**

A lens located in front of an eyepiece; increases the effective focal length of the objective lens; increases the power of an eyepiece (ie: a 2X Barlow lens doubles the power of the eyepiece).

Constellation:

A pattern of stars which represents a particular shape or object. Because of an agreement made by astronomers who belong to a world wide organization called the International Astrophysical Union or IAU, there are 88 recognized constellations in the sky, many of which can be seen from America.

Declination**Axis & Circle:**

The North/South axis of an Equatorial mount. It corresponds to terrestrial latitude. The declination circle calibrates declination movement.

Erecting Lens**System:**

An erecting lens system (a prism or series of lenses) is located between the objective lens and the eyepiece. Images seen without it are reversed/upside down. This system re-inverts the image captured by the objective lens.

Eyepiece

An eyepiece fits into the focus tube of the telescope. Each eyepiece will have a single power. Inter-changeable eyepieces give the viewer the flexibility to increase or decrease the viewing power. The eyepiece is the second primary optical element in your telescope.

Focal Length:

The distance (measured in millimeters) from the objective lens to the focal point where collected light rays come into focus.

Galaxy:

A very large group of stars which travel through space like a giant herd. There are more than ten billion galaxies in space. Each one contains anywhere from hundreds of millions of stars to trillions of stars. Our galaxy has at least 100 billion stars of which the sun is just one.

Horizon:

This is the boundary where the land appears to meet the sky. The word horizontal comes from horizon.

Hour Axis**& Circle:**

The axis of an equatorial mount that points to their celestial pole and is parallel to the Earth's rotational axis. This axis rotates along the Right Ascension which corresponds to the Earth's longitude. The Hour Circle calibrates motion around this axis. The Hour Axis is sometimes referred to as the "Polar Axis."

**Light
Gathering
Power:**

A telescope's ability to collect light depends on the diameter (aperture) of the objective lens. A 50mm objective collects almost 50 times more light than the human eye.

**Magnification/
Power:**

The amount of image enlargement a telescope produces. Expressed as a number followed by "X."

Methane:

A gas which is very common on the larger planets like Jupiter, Saturn, Uranus, and Neptune. We have some on Earth. It is associated with decomposing matter and oil wells. Methane is made up of a carbon atom and four hydrogen atoms.

Nebula:

A huge cloud of gas (mostly hydrogen) and dust found between the stars or associated with stars that have either exploded to one degree or another or stars that are in the process of forming. About the closest one, about 400 L.Y. away, is found near the star Merope in the asterism called the "Seven Sisters" or the Pleiades, part of the constellation Taurus. You can't see it except on photographs. The brightest is the Orion Nebula which is about 1,500 L.Y. distant.

Number

Short Hand:

A terrific way to deal with numbers which are very big or very small. The number above the ten is called an exponent. It tells you the number of place of the number in front of the ten. If the number above the ten (we call it the exponent) has a minus sign in front of it, that tells you the entire number is smaller than one and by how many multiples of ten. If the exponent does not have a minus sign in front of it, it tells you that the number is bigger than one and by how many multiples of ten. Your calculator probably has a button that looks like this: EXP. That is the button to use for this type of short hand.

Oort Cloud:

It is now thought by many astronomers that a huge cloud of comets orbits the Sun at a distance of 100,000 A.U.I. There may be as many as a billion or hundred billion comets in the cloud. Another group of astronomers suspects that thousands of comets from the cloud bombard the inner solar system every 26 million years, or so.

Parsec:

A parsec is another unit of measure that astronomers use for distances between stars and galaxies. It is a bigger unit than a light year. Each parsec equals 3.26 light years. Each light year, then, equals about 1/3 parsec. The term parsec comes from joining two word *parallax* and *second*, together. A single parsec is equal to 206,265 A.U.

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Photons:	These can be thought of as individual packets of energy of visible light which travel, in space, at 180,000 miles per second. You can't weigh them because they have no mass when at rest. All photons (red through violet) travel at the same speed in space.
Planet:	A planet is a sphere shaped object which is in orbit around the star from which it formed. The only planets in the entire universe we know for certain are right here in our solar system. Astronomers accidentally discovered planetary material circling the star Vega when they were testing a satellite called I.R.A.S. a few years ago. Many astronomers believe that planets have formed around other stars but the search goes on.
Refraction:	This is the change in direction of photons as they pass from one substance to another. By carefully shaping the surface of a piece of clear glass, we can cause the photons to bend, or refract, so that an image is formed by the glass lens.
Resolution:	A telescope lens's capacity to capture the detail in a viewed object.
Setting	The marked dials that calibrate motion along the two major axes of an equatorial mount (Hour Axis and Declination Axis) that correspond to the Earth's latitude and longitude.
Circles:	
Star:	Normal stars are giant spheres made of mostly hydrogen, some helium, and a little bit of most other elements thrown in. They range in size from a hundred thousand miles to hundreds of millions of miles in diameter. They are entirely gaseous and produce their own light.
Star	
Diagonal:	A wedge shaped piece of optical quality glass that diverts the path of light 90°. The Star Diagonal permits the viewer to adjust the angle of the eyepiece to the most comfortable viewing position.

The Bushnell Warranty

10

Your BUSHNELL Telescope is unquestionably warranted to be free of defects in material and workmanship for the lifetime of the original owner.

This Lifetime Limited Warranty is an expression of our confidence in the materials and mechanical workmanship of this Company's optical products and assures years of convenient, dependable service. In the event of a defect under this warranty, we will, at our option, repair or replace the product provided that you return the product postage prepaid to: Bausch & Lomb Sports Optics Division, 9200 Cody Overland Park, Kansas 66214, together with a check in the amount of \$7.50 to cover the cost of handling. Please also include your name and address and an explanation of the defect.

This warranty does not cover defects caused by misuse or improper handling, installation, or maintenance of the product.

This warranty gives you specific legal rights and you may have other rights which vary from state to state.



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